MLT / FPT / CSWT | SEMESTER 1

BS105 Applied Chemistry

Quantum concepts Electrons are stranger than tiny balls

Today: wave-particle idea, De Broglie, and Heisenberg.
Stories first. Almost no maths.

Class 3

Qualitative only

BRIDGE FROM LAST CLASS

Bohr helped. But electrons are not little planets.

- Bohr fixed the spiral problem with allowed levels.
- Still, nature is more interesting than that picture.
- Electrons sometimes act like particles, sometimes like waves.
- We need a few new words before quantum numbers next class.

TODAY'S MAP

Four ideas. Keep them light.

1

Wave-particle

One thing, two faces.

2

Photoelectric + double slit

Extra stories for sense.

3

De Broglie

Matter can have wavelength.

4

Uncertainty

Syllabus point. Idea only.

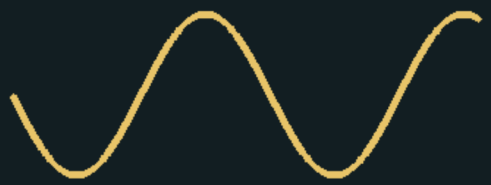
BIG IDEA

Wave-particle duality

Same electron can show both faces

Particle

small ball, hits things



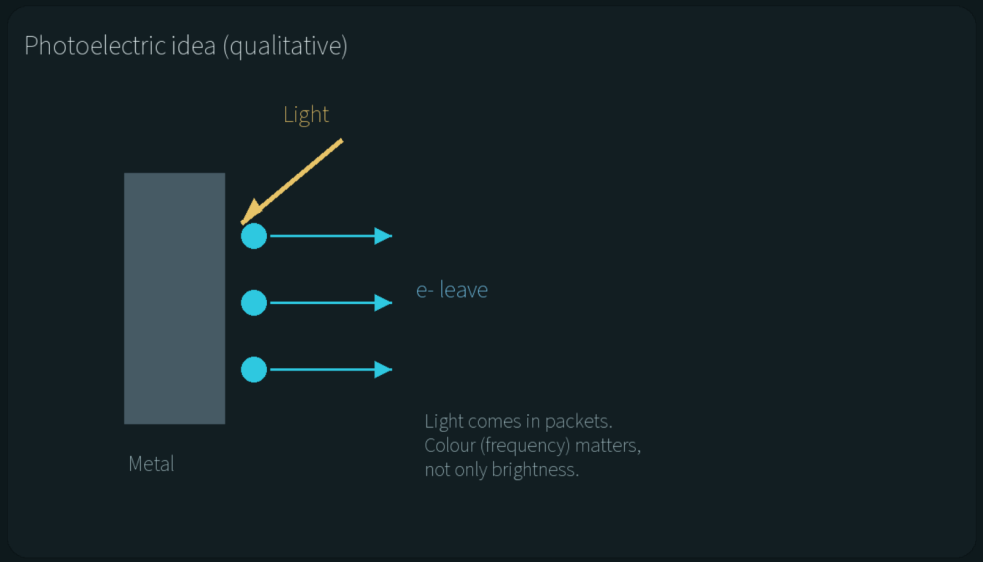
Wave

spreads and interferes

Light can behave like a wave and like a particle.
Electrons can too. That is the strange but real story.

EXTRA STORY | NOT HEAVY MATHS

Photoelectric effect -- light kicks electrons out

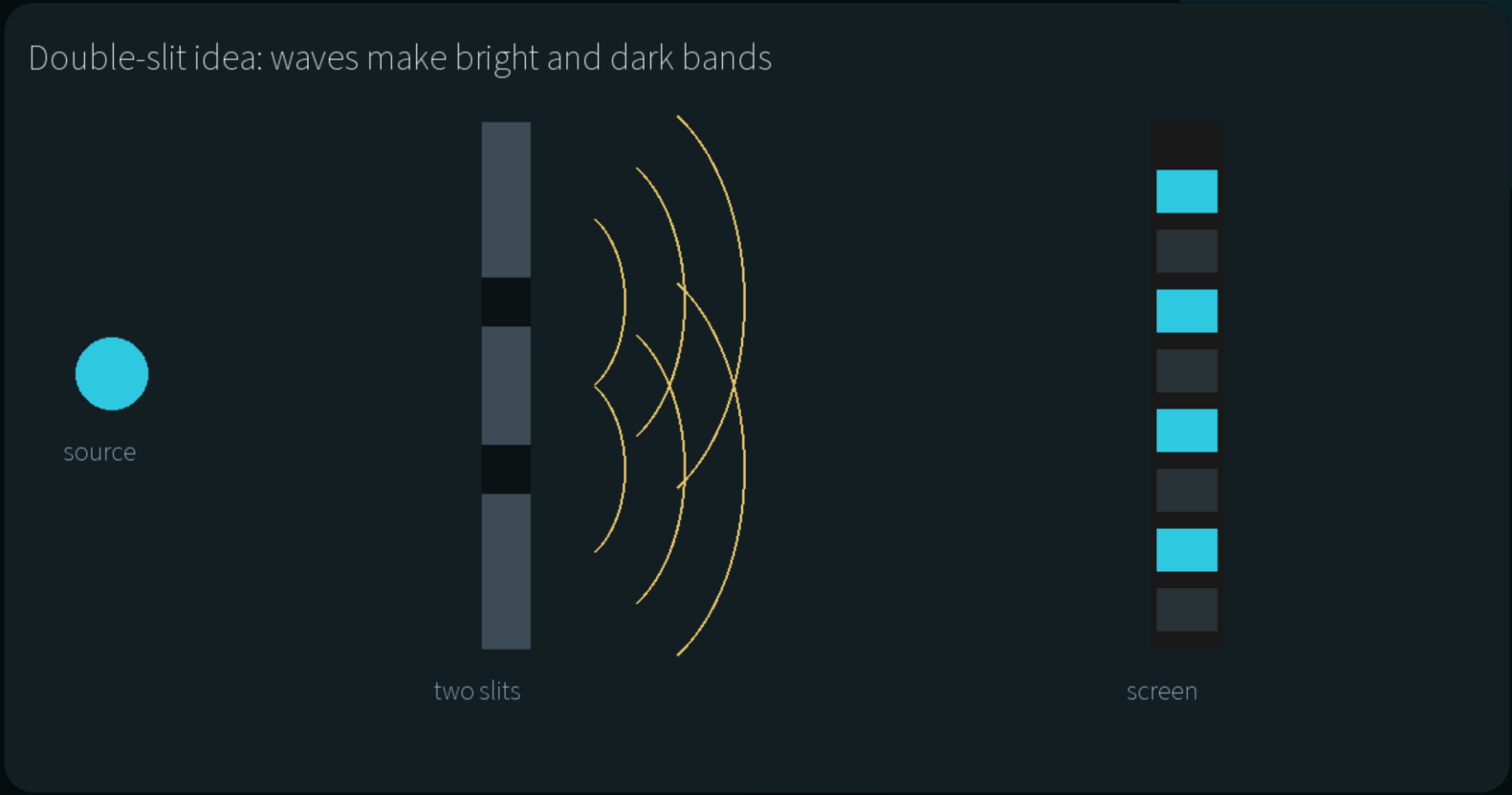


What we notice

- Light falls on metal.
- Electrons can leave.
- Colour of light matters.
- Too red? Nothing happens.
- Blue enough? Electrons leave.
- So light comes in packets.

EXTRA STORY

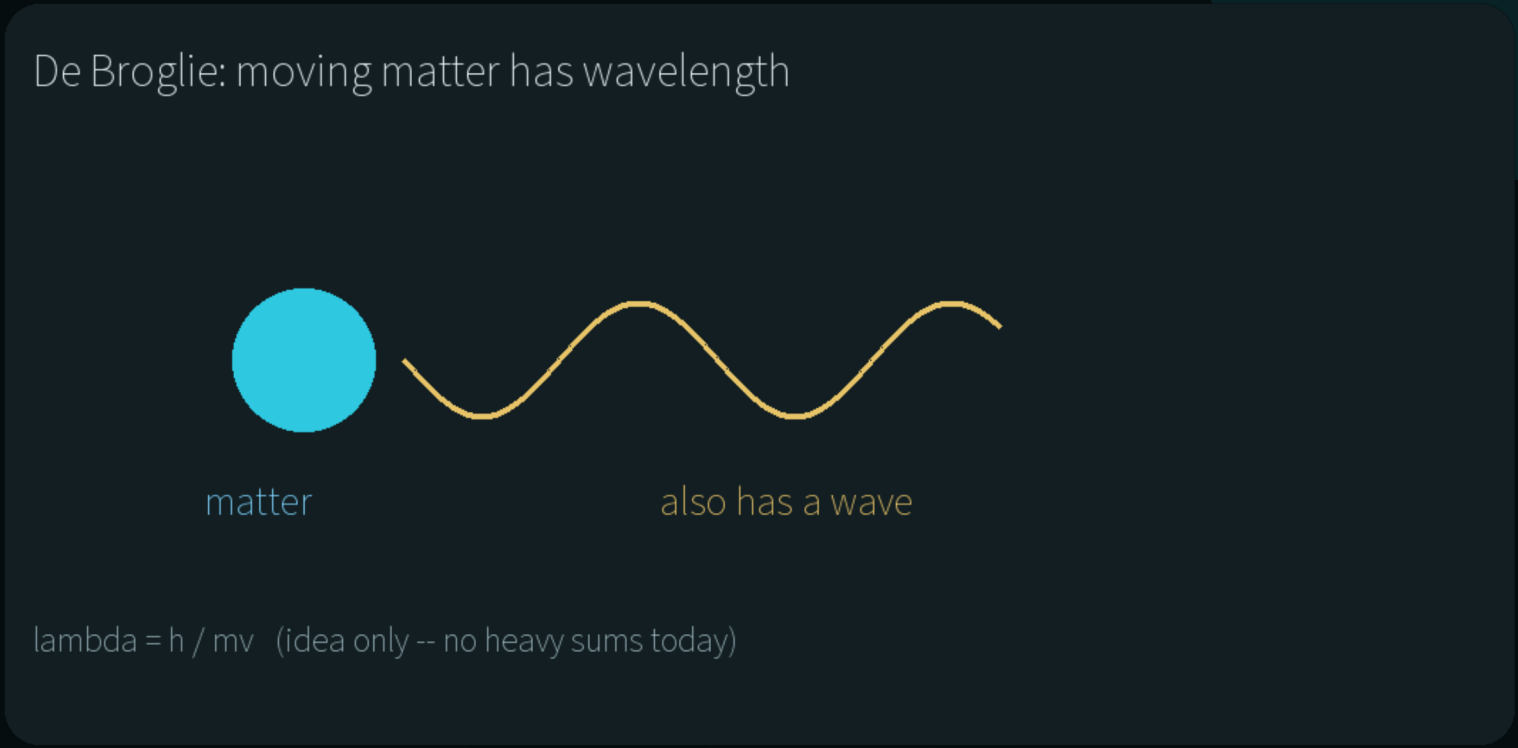
Double-slit -- waves leave a pattern



Bright and dark bands mean interference -- a wave signature.
Electrons can show this pattern too. Strange, but true.

DE BROGLIE

Moving matter also has a wavelength



Faster or heavier -> shorter wavelength.
For cricket balls the wave is tiny. For electrons it matters.

IN PLAIN WORDS

What De Broglie gives us

- An electron is not only a tiny ball.
- It also has a wave associated with its motion.
- That is why electron diffraction and orbitals make sense later.
- Today we only need the idea, not long calculations.

SYLLABUS POINT

Heisenberg uncertainty principle

You cannot know exact position and exact speed of an electron at the same time.
This is nature's limit -- not a bad instrument.

WRITE THIS FOR EXAMS

Uncertainty in three lines

- It is impossible to measure exact position and exact momentum of a tiny particle together.
- If position is known more sharply, momentum becomes more uncertain -- and the other way round.
- So we stop talking about a fixed path of the electron. We talk about orbitals later.

WHY THIS MATTERS

This opens the door to orbitals

- Electrons do not move on neat little planet tracks.
- We can only talk about where an electron is likely to be.
- That region is called an orbital -- next class.
- Quantum numbers will label those orbitals.

FOR YOUR NOTES

What is syllabus, what is support

Must know

- Heisenberg uncertainty (idea).
- Wave-particle idea (simple).
- De Broglie idea (simple).

Support stories

- Photoelectric effect.
- Double-slit experiment.
- Help understanding only.

BEFORE YOU GO

Today in five lines

- Electrons can act like particles and like waves.
- Photoelectric story: light comes in packets.
- Double-slit story: waves make bright and dark bands.
- De Broglie: moving matter has a wavelength.
- Heisenberg: exact position and exact speed cannot both be known.